16 March 1979

Square Radome
Structural Engineering
  Handbook
p 19-16 thru 19-17

WINDLOADING REQUIREMENTS

1. The windload from 150 mph wind is computed as follows:

$$psf = .00256V^2 \qquad V = mph$$
$$= .00256(150)^2$$
$$= 57.6 \text{ psf}$$

2. The windload on the shed with 2 panels removed and a
    40 mph wind. The positive pressure is assumed to be
    at full load while the negative pressure, due to a
    "vacuum" on the leeward side is 0.40.

$$psf = .00256V^2 \text{ (positive factor + negative factor)}$$
$$= .00256(40)^2(1.00 + 0.40)$$
$$= (.00256)(1600)(1.4)$$
$$= 5.7344 \text{ psf}$$

3. A 60 mph wind with 30 psf load from snow or ice

$$psf = (.00256)(V^2) + 30$$
$$= (.00256)(3600) + 30$$
$$= 9.216 + 30$$
$$= 39.216 \text{ psf}$$

4. The requirement to resist 70 psf with no wind appears
    to be the worst case for the roof. If this load is ice,
    the ice would have to be

$$\frac{(70)(12)}{(62.4)(.88)} = 15 \text{ inches thick}$$

If the load is snow, the depth would be

$$\frac{(70)(12)}{(62.4)(.125)} = 107.7 \text{ inches or about 9 feet deep}$$

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Ref: DCE-MTB-535

DESIGN AN ADAPTER SO THAT EXISTING FOUNDATION BOLTS CAN BE USED WITH A NEWER MODEL ANTENNA
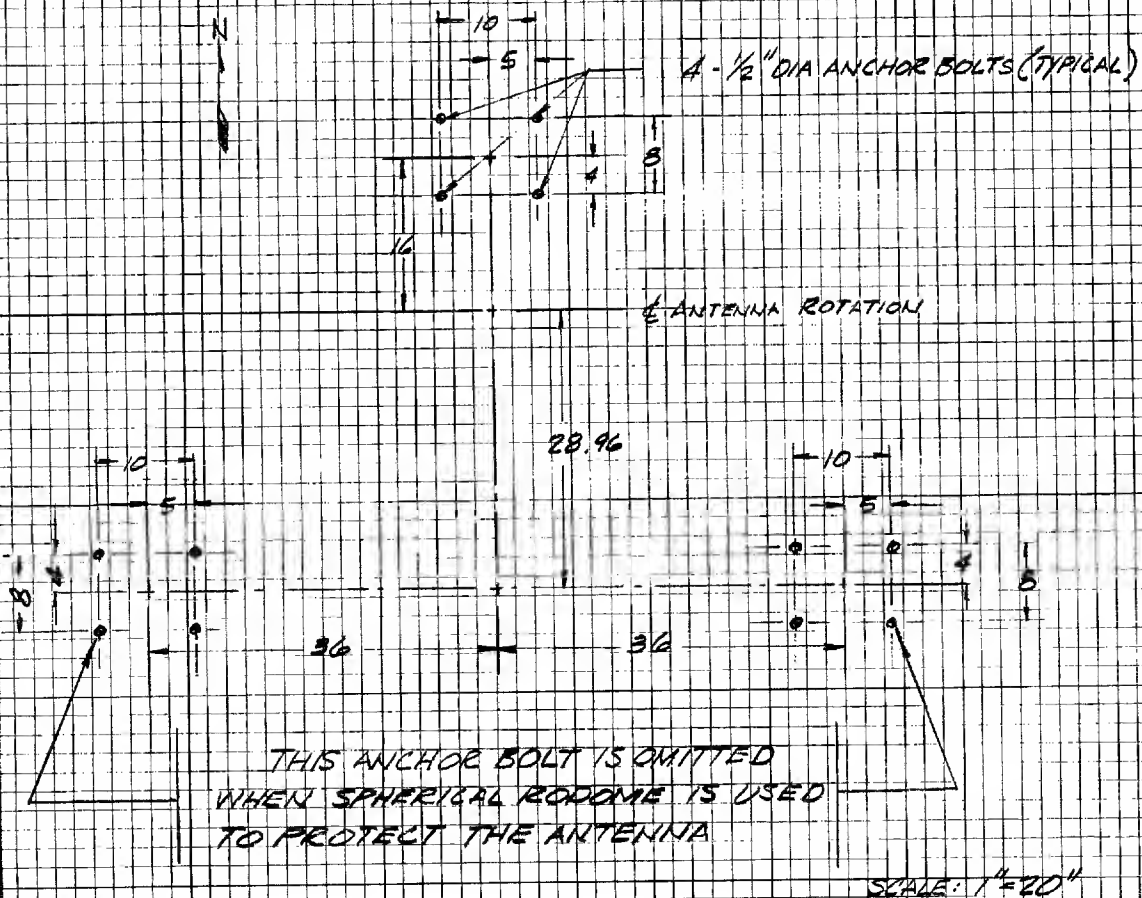
FURNISHED ARE

OLD ANTENNA BOLT LAYOUT
NEW ANTENNA BOLT LAYOUT
CLEARANCES OF NEW ANTENNA IN TWO STYLES OF RADOME
CALCULATED WIND LOADS ON NEW ANTENNA.

FURNISH PLANS AND SPECIFICATIONS TO CONSTRUCT ADAPTER
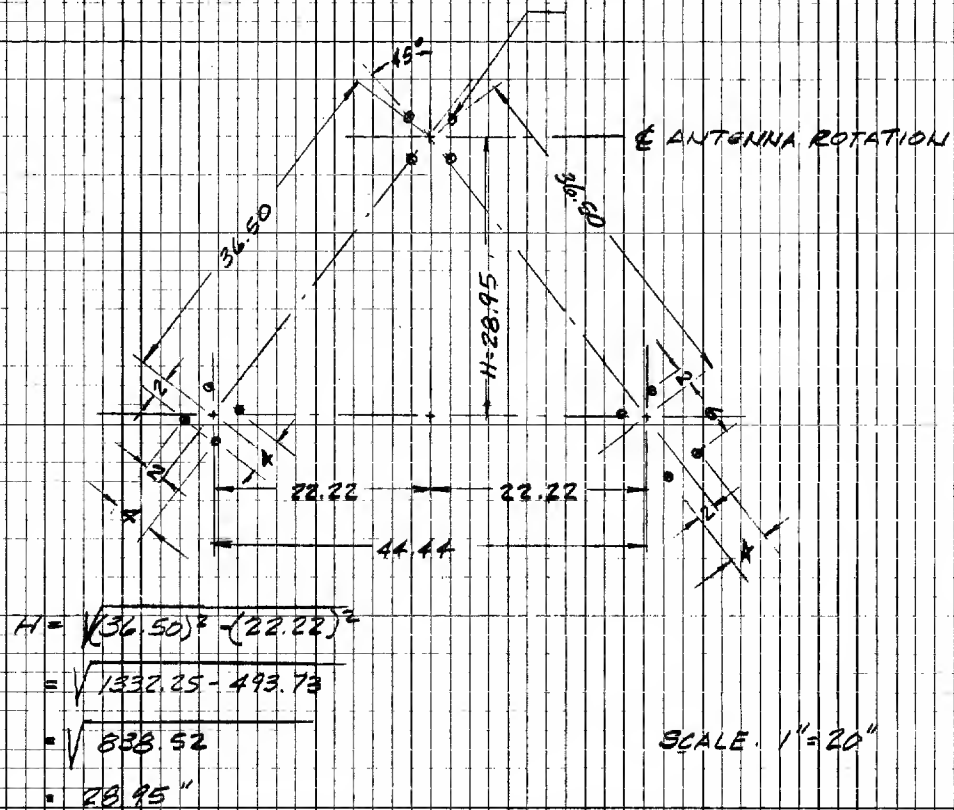
EXISTING ANTENNA BOLT LAYOUT

4 - ½" DIA ANCHOR BOLTS (TYPICAL)

₵ ANTENNA ROTATION

28.96

THIS ANCHOR BOLT IS OMITTED WHEN SPHERICAL RADOME IS USED TO PROTECT THE ANTENNA

SCALE: 1"=20"

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NEW ANTENNA BOLT LAYOUT

$\mathcal{C}$ ANTENNA ROTATION

36.50

36.50

H=28.95

45°

22.22   22.22

44.44

$$H = \sqrt{(36.50)^2 - (22.22)^2}$$

$$= \sqrt{1332.25 - 493.73}$$

$$= \sqrt{838.52}$$

$$= 28.95''$$

SCALE : 1" = 20"

ANTENNA ADAPTER BOLT LAYOUT COMBINING OLD AND NEW REQ'M'TS

FABRICATE IN 2 PIECES

PART Ⓐ
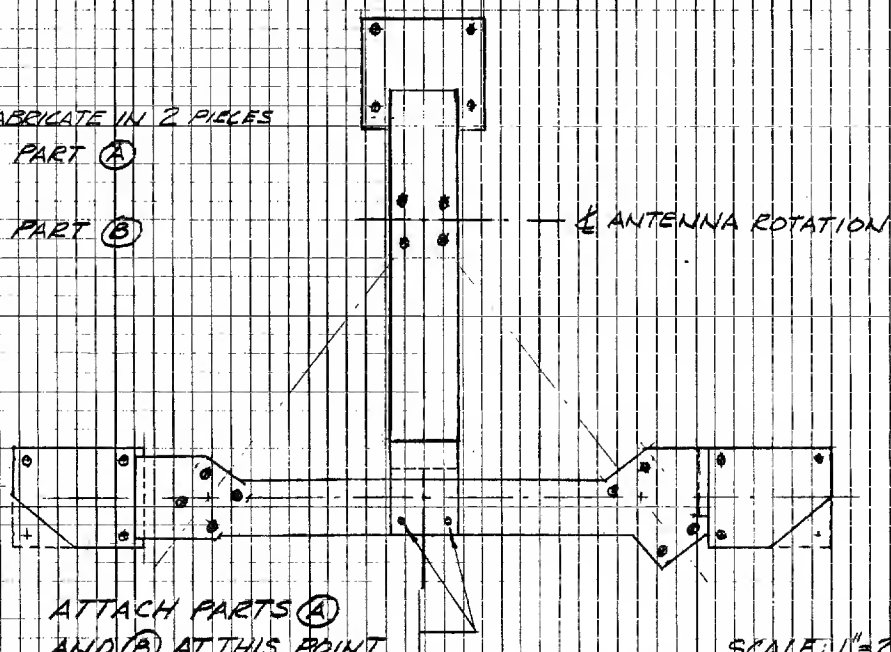
PART Ⓑ

$\mathcal{C}$ ANTENNA ROTATION

ATTACH PARTS Ⓐ
AND Ⓑ AT THIS POINT
WITH 2 - ½" DIA BOLTS

SCALE : 1" = 20"

FPI-MI-10 X 10 TO 1 INCH
10TH LINE HEAVY

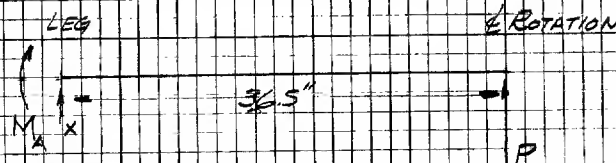| SEE RECO	ANTENNA ADAPTER / COMMO	JAN 16 1979	L.L.C.	3/9

LOAD CALCULATIONS

THE WEIGHT OF THE ANTENNA IS CONCENTRATED DOWNWARD AT THE CENTER OF THE POINT OF ROTATION. OF A TOTAL WEIGHT OF 800 POUNDS, ASSUME 700 POUNDS ACTS ON THE ADAPTER AT THIS POINT UNDER A "NO WIND" CONDITION.

FROM PREVIOUS CALCULATIONS FOR WIND LOADS

150 mph yeilds 5405 lbs/ft of moment

100 mph yeilds 2400 lbs/ft. of moment

USING THE MOMENT ARM OF _____ INCHES, THE FOLLOWING ADDITIONAL FORCE WOULD BE ADDED TO THE ADAPTER PART Ⓐ AT THE POINT OF ROTATION.

LEG   ₵ ROTATION

M_a x |—— 36.5" ——| P

150 mph   100 mph

$\sum M_x = 0$ $\sum M_x = 0$

$5405 = \dfrac{36.5}{12} P_{150}$ $2400 = \dfrac{36.5}{12} P_{100}$

$P_{150} = \dfrac{(5405)(12)}{36.5}$ $P_{100} = \dfrac{12(2400)}{36.5}$

$P_{150} = 1777\ lbs.$ $P_{100} = 789\ lbs$

TOTAL FORCE AT P

1777	789
700	700
2477	1489

FOR PART Ⓐ ASSUME THAT THE END ATTACHED TO PART Ⓑ IS FREE TO ROTATE WHILE THE END ATTACHED TO THE OLD FOUNDATION BY 4 EXISTING BOLTS IS FIXED OR MOMENT RESISTANT.

PART Ⓐ   P = 2477# $R_B = \dfrac{2477(16)^2}{(2)(45)^3}(29 + 90)$

|—— 29" ——|—— 16" ——| = 414#
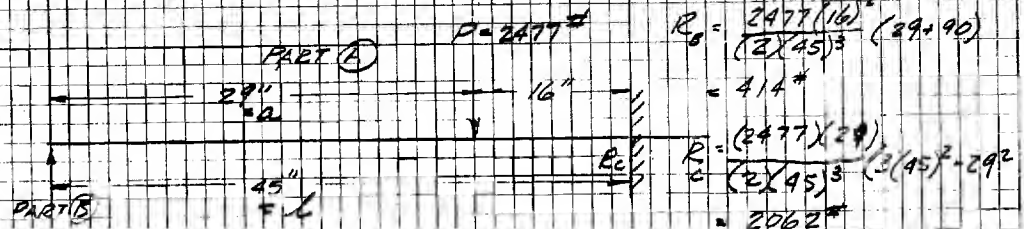
PART Ⓑ |—— 45" ——| $R_c = \dfrac{(2477)(29)}{(2)(45)^3}(3(45)^2 - 29^2)$

                                              = 2062#

THE MAXIMUM DEFLECTION, Δ_{max}, IS THE REPRESENTED BY

$$\Delta_{max} = \dfrac{Pa(L^2 - a^2)^3}{3EI(3L^2 - a^2)^2}$$

AND E = 30 × 10⁶ FOR STEEL
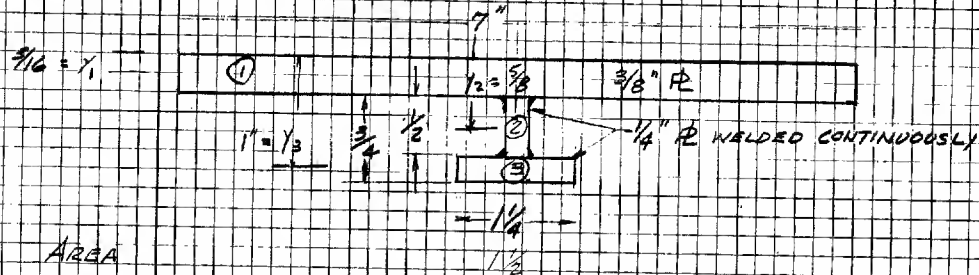
I = MOMENT OF INERTIA OF SECTION

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FROM ADAPTER SKETCH ON PAGE 2, PART Ⓐ IS APPROXIMATELY 7" WIDE AT THE AREA WHERE BENDING WILL OCCUR. USE THE FOLLOWING STIFFENED SECTION.

AREA

$$A = A_① + A_② + A_③$$

$$= (7)(\tfrac{3}{8}) + (1\tfrac{1}{2})(\tfrac{1}{4}) + (1\tfrac{1}{4})(\tfrac{1}{4})$$

$$= 2.625 + 0.125 + 0.3125$$

$$= 3.0625 \ in.^2$$

CENTROID - $\bar{y}$

$$\Sigma A \bar{y} = A_1 y_1 + A_2 y_2 + A_3 y_3$$

$$3.0625 \bar{y} = (2.625)(0.1875) + (0.125)(0.625) + (0.3125)(1.00)$$

$$3.0625 \bar{y} = 0.4922 + 0.0781 + 0.3125$$

$$\bar{y} = \frac{0.8828}{3.0625}$$

$$\bar{y} = 0.2883"$$

MOMENT OF INERTIA - $\bar{I}$

$$\bar{I} = I_1 + A_1(\bar{y}-y_1)^2 + I_2 + A_2(\bar{y}-y_2)^2 + I_3 + A_3(\bar{y}-y_3)^2$$

$$= \tfrac{1}{12}(7)(\tfrac{3}{8})^3 + 2.625(0.2883-0.1875)^2 + \tfrac{1}{12}(\tfrac{1}{4})(\tfrac{1}{2})^3 + 0.125(0.625-0.2883)^2$$

$$+ \tfrac{1}{12}(1\tfrac{1}{4})(\tfrac{1}{4})^3 + 0.3125(1.000-0.2883)^2$$

$$= (.5833)(.0527) + 2.625(.0102) + .0026 + 0.125(.1134)$$

$$+ .1042(.0313) + 0.3125(.5065)$$

$$= .0307 + .0268 + .0026 + .0142 + .0033 + .1583$$

$$= .2359$$

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Option 2. Increase width of bottom member from $1\frac{1}{4}"$ to $1\frac{1}{2}"$

Area

$$A = A_1 + A_2 + A_3$$

$$A = 2.625 + 0.125 + 0.375$$

$$A = 3.125$$

Centroid $- \bar{y}$

$$\Sigma A \bar{y} = A_1 y_1 + A_2 y_2 + A_3 y_3$$

$$3.125 \bar{y} = 0.4922 + 0.0781 + 0.375$$

$$\bar{y} = \frac{0.9453}{3.125}$$

$$\bar{y} = 0.302$$

Moment of Inertia $- \bar{I}$

$$I = I_1 + A_1(\bar{y} - y_1)^2 + I_2 + A_2(y_2 - \bar{y})^2 + I_3 + A_3(y_3 - \bar{y})^2$$

$$= .0307 + .0344 + .0026 + .0130 + .0034 + .1827$$

$$= .2673$$

Deflections $- \Delta$

$$\Delta = \frac{Pa(l^2 - a^2)^3}{3EI(3l^2 - a^2)^2}$$

$$= \frac{P}{I}\left[\frac{a(l^2 - a^2)^3}{3E(3l^2 - a^2)^2}\right]$$

$$= \frac{P}{I}\left[\frac{29(45^2 - 29^2)^3}{(3)(30)(10^6)((3)(45^2) - 29^2)^2}\right]$$

$$= \frac{P}{I}\left[\frac{29(1184)^3}{(3)(30)(10^6)(5234)^2}\right]$$

$$= \frac{P}{I}\left[\frac{(29)(1.658)(10^9)}{(3)(30)(10^6)(2.139)(10^7)}\right]$$

$$= \frac{P}{I} .00001953$$

$$\Delta_{150} = \frac{(2477)}{.2359}(.00001953) = .205 \text{ in}$$

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$$\Delta_{150 \atop option} = \frac{2477}{.2673}(.00001953)$$

$$= .181 \text{ in}$$

$$\Delta_{100} = \frac{1489}{.2359}(.00001953)$$

$$= .123$$

$$\Delta_{100 \atop option} = \frac{1489}{.2673}(.00001953)$$

$$= .109 \text{ in}$$

STRESS IN SECTION AT CONNECTION TO EXISTING NORTH ANCHORS

$$M = \frac{f I}{c}$$

$$f = \frac{M c}{I}$$

$$M_{Rotation} = 414\left(\frac{29}{12}\right)$$

$$= 1000 \text{ ft}^{\#}$$

$$M_{Fixed} = \frac{\left(2477\right)\left(\frac{29}{12}\right)\left(\frac{6}{12}\right)}{2\left(\frac{45}{12}\right)^2}\left(\frac{29}{12} + \frac{45}{12}\right)$$

$$= \frac{(2477)(2.417)(1.333)}{(2)(14.062)}(6.167)$$

$$= 1749.97 \text{ ft}^{\#} \qquad \boxed{1051 \text{ ft.}^{\#} \text{ for } 100 \text{ mph}}$$

$$f = \frac{(1749.97)(12)(1.125-.300)}{.2673}$$

$$= (1749.97)(12)(0.823)$$

$$= 64,620 \text{ psi}$$

Since the upper limit of the most readily available steel, A-36, is 36,000 psi yield, the adapter must be stiffened at this point to insure no inelastic deformation during 150 mph wind condition.
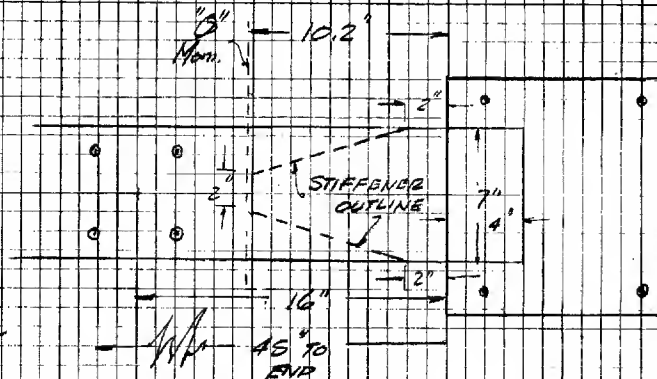
STIFFENER FOR PART (A) AT CONNECTION TO EXISTING ANCHOR BOLTS

POINT OF O MOMENT

$$= \frac{Pa}{Z}$$

$$= \frac{(2477)(29'')}{2062}$$

$$= 34.8'' \text{ from } P_2 \quad \therefore \quad 45'' - 34.8 = 10.2''$$

ASSUME STIFFENER TO BE $\frac{1}{2}''$ THICK EXTENSION OF SPACER BETWEEN THE THE PLATES. THE EFFECTIVE CROSS SECTION WOULD THEN BE 7" WIDE AND $\frac{7}{8}''$ THICK

$$I = \frac{1}{12} bh^3$$

$$= \left(\frac{1}{12}\right)(7)\left(\frac{7}{8}\right)^3$$

$$= 0.391$$

$$f = \frac{Mc}{I}$$

$$= \frac{(749)(12)\left(\frac{7}{16}\right)}{.391}$$

$$= 23,484 \text{ psi} \quad \text{WHICH IS WITHIN THE } 36,000 \text{ psi LIMIT}$$

WOULD STIFFENER BE REQUIRED UNDER 100 mph CONDITIONS

$$f = \frac{Mc}{I}$$

$$= \frac{(1000)(12)(.823)}{.2673}$$

$$= 36,947 \text{ psi} \quad \text{WHICH IS VERY CLOSE TO } 36,000 \text{ psi LIMIT}.$$
$$\therefore \text{ STIFFENER NOT REQUIRED}$$

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ESTIMATED WT.

PART (A)

3/8" R
$(12)(7) = 84$
$(40)(7) = 280$
$(12)(13) = \dfrac{156}{520}$"

$\dfrac{520}{144} = 3.61\ \square^\# @ 15.3\ ^\#/_{fr^2} = 55.23$

1/2" R
$(6)(7) = 42$
$(2\tfrac12)(8) = 20$
$(2)(8) = \dfrac{16}{78}$

$\dfrac{78}{144} = .54\ \square^\# @ 20.4\ ^\#/_{fr^2} = 11.02$

1/4" R
$(1\tfrac14 + \tfrac12)(35) = 61.25$

$\dfrac{61.2}{144} = .425\ \square^\# @ 10.2\ ^\#/_{fr^2} = \underline{4.34}$

$\underline{\underline{70.6^\#}}$

PART (B)

3/8" R
$(14)(10\tfrac13)(2) = 294$
$-(5)(7) = -35$
$(38)(6) = 228$
$(2\tfrac12)(6) = 15$
$(6)(11) = 66$
$(5)(\tfrac{8}{2}) = 20$
$(7)(\tfrac{9}{2}) = 31.5$
$(7)(5) = 35$
$(5)(\tfrac{5}{2}) = \dfrac{12.5}{667}$

$\dfrac{667}{144} = 4.63^\# @ 15.3\ ^\#/_{fr^2} = 70.84^\#$

1/2" R
$(2)(7) = 14$
$(2)(8) = \dfrac{16}{30}$

$\dfrac{30}{144} = .21\ ft^2 @ 20.4\ ^\#/_{fr^2} = 4.25$

1/4" R $(1\tfrac14 + \tfrac12)(35) = 61.25$ $\dfrac{61.25}{144} = .425\ ft^2 @ 10.2\ ^\#/_{fr^2} = \underline{4.34}$

$\underline{\underline{79.43^\#}}$

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Total Wt.

Part Ⓐ = 70.6#

Part Ⓑ = 79.4#

150.0# plus nuts, bolts, washers